BEST AVAILABLE COPY

CLIPPEDIMAGE= JP407159636A

PAT-NO: JP407159636A

DOCUMENT-IDENTIFIER: JP 07159636 A

TITLE: WAVEGUIDE TYPE OPTICAL PARTS AND THEIR ADJUSTMENT METHOD

PUBN-DATE: June 23, 1995

INVENTOR-INFORMATION:
NAME
EMORI, TOSHIYUKI

ASSIGNEE-INFORMATION:

NAME	COUNTRY
FUJITSU LTD	N/A

APPL-NO: JP05308791

APPL-DATE: December 9, 1993

INT-CL (IPC): G02B006/122;G02B006/255 ;G02B006/30

ABSTRACT:

PURPOSE: To provide a waveguide element composed to facilitate coupling to an optical fiber and an adjustment method at the time of coupling the optical fiber to this waveguide element.

CONSTITUTION: A quartz optical waveguide substrate 5 constituted by providing the surface of a substrate 1 with an underclad layer 2 and providing the surface of this underclad layer 2 with a ridge-shaped core 3 corresponding to a waveguide pattern and providing an overclad layer 4 covering the underclad layer 2 and the core 3 is provided with a metallic pattern 6 corresponding to the waveguide pattern on the overclad layer 4, by which the waveguide element is constituted. Alignment is executed with the metallic

pattern 6 as a
reference, by which the optical axes of the core 3 and the optical fiber are
aligned at the time of forming the waveguide optical parts by coupling the
waveguide element and the optical fiber.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention is used when combining optically between the optical waveguides formed on the separate substrate in optical-communication equipment etc. about the optical coupling structure between optical waveguides, and it is useful.

[0002]

[Description of the Prior Art] The optical coupling structure of combining between the optical waveguides formed on the separate substrate in the conventional technology has a common method of making the end face of an optical waveguide couple directly, as shown in drawing 7. The substrate [layer / clad / of the 1st optical waveguide] in which the core of the 1st optical waveguide and 2 are formed in, and, as for the inside of drawing and 1, the 1st core 1 and clad layer 2 of an optical waveguide are formed, as for 3, and 4 show the substrate / layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 6, the 2nd core 4 and clad layer 5 of an optical waveguide

[0003]

[Problem(s) to be Solved by the Invention] the optical coupling structure between the optical waveguides concerning the conventional technology like **** -- setting -- the core 1 of the 1st optical waveguide, and the core 4 of the 2nd optical waveguide -- combination -- in order to make it couple directly efficiently, it is required to control the angle at which it not only carries out alignment in three dimensions, but each optical waveguide makes the end face of each optical waveguide, and to make the direction of an optical axis in agreement, and the alignment is difficult Thus, with the conventional optical coupling structure,-like-dimensional [3] alignment and highly precise alignment of three or more shafts called angle adjustment are required for the optical coupling of the optical waveguides formed in the separate substrate, and there is a fault that optical coupling is difficult. Moreover, there is a problem of the lightwave signal from the 1st optical waveguide reflecting by the 2nd optical-waveguide end face, and becoming easy to be influenced of reflective after-tack light.

[0004] this invention aims at offering the optical coupling structure between the optical waveguides which can remove the influence of the reflective after-tack light at the time of making unnecessary highly precise alignment of three or more shafts like ****, and making end faces couple directly in view of the above-mentioned conventional technology.

[0005]

[Means for Solving the Problem] The composition of this invention which attains the above-mentioned purpose between the 1st optical waveguide formed on the 1st substrate, and the 2nd optical waveguide formed on the 2nd substrate It is the optical coupling structure optically combined through the 3rd optical waveguide which has flexibility and was formed on the 3rd substrate which is moreover film structure. The width of face of the both ends of the 3rd optical waveguide is equal to the width of face of the 1st and 2nd optical waveguides, and it is characterized by the both ends of the 3rd optical waveguide contacting respectively the both ends of the 1st and 2nd optical waveguides.

[0006]

[Function] By according to this invention of the above-mentioned composition, contacting the film-like 3rd optical waveguide which has flexibility to a part of field of the longitudinal direction of the 1st and 2nd optical waveguides, and combining between the 1st and 2nd optical waveguides The flexibility of a film can be used, the alignment of the angle which the flat surface in which the alignment of the height direction of the 1st and the 2nd optical waveguide, and the 1st and the 2nd optical waveguide are formed makes becomes unnecessary, and alignment work can be sharply shortened compared with direct coupling of the conventional end faces. Moreover, by not making end faces couple directly with the optical coupling of optical waveguides, the influence of reflective after-tack light can be prevented.

[0007]

[Example] The example of this invention is explained in detail based on a drawing below.

[0008] Drawing 1 is the cross section showing the 1st example of this invention for a strip type optical waveguide. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, 7 is the 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the core of the 3rd optical waveguide and 8 are formed in, and, as for 9, the 3rd core 7 and clad layer 8 of an optical waveguide are formed.

[0009] After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the 1st which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 2nd substrates 3, and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is several microns - about 50 microns, and core width of face is several microns - about 50 microns.

[0010] a core 7 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the clad layer 8], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- about -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle This core 7 may be covered in the thin optical-waveguide clad layer several microns or less if needed. in this way, the 3rd optical waveguide concerning this example is the 1st and 2nd optical waveguides and these width of face, and has flexibility -- it has become

[0011] After carrying out the spin coat cure of an optical-waveguide core layer and the clad layer and forming the mask for optical-waveguide core formation by the lift-off method etc. on the silicon wafer which is not illustrated, formation of the 3rd optical waveguide concerning this example forms a core 7 by the same method as ****, and ablation ****** acquires the interface of optical-waveguide clad and a silicon substrate. Although the clad layer 8 pastes up the 3rd substrate 9, such as an acrylic, further, this substrate 9 can also be omitted if needed.

[0012] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 7 probably, a core 7 is completely contacted to a part of field of the longitudinal direction

of a core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 8. By contacting a core 7 and a core 4 by the same method, the 1st and 2nd optical waveguides can be combined.

[0013] Drawing 2 is the cross section showing the 2nd example of this invention. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, The 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the core of the 3rd optical waveguide and 8 are formed in, and, as for 7, the 3rd optical-waveguide core 7 and clad layer 8 are formed, as for 9, and 10a and 10b show the salient formed on the 3rd optical-waveguide core. After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the substrate 3 which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is several microns - about 50 microns, and core width of face is several microns - about 50 microns.

[0014] a core 7 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the clad layer 8], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle

[0015] Salients 10a and 10b are formed on the core 7, and it consists of the same refractive index as this core 7, width of face, and thickness, and the size of the longitudinal direction is in a core 7, and consists of cores 1 to the length (- unity coupling length) from which the optical power shift to a core 4 from a core 7 serves as the maximum. In addition, Salients 10a and 10b may be covered by thin optical-waveguide clad several microns or less if needed.

[0016] In this way, the 3rd waveguide concerning this example is the 1st and 2nd waveguides and these width of face, and it has Salients 10a and 10b while it has flexibility.

[0017] Formation of the 3rd optical waveguide concerning this example carries out the spin coat cure of an optical-waveguide core layer and the clad layer on the silicon wafer which is not illustrated, for example. After forming the mask for optical-waveguide core formation by the lift-off method etc., the optical-waveguide layer for heights and the mask for height formation are formed by the same method. Then, after forming simultaneously Salients 10a and 10b and a core 7 by reactive ion etching etc., it is obtained by exfoliating the interface of optical-waveguide clad and a silicon substrate. Although the clad layer 8 pastes up the 3rd substrate 9, such as an acrylic, further, this substrate 9 can also be omitted if needed.

[0018] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 7 probably, Salients 10a and 10b are completely contacted to a part of field of the

longitudinal direction of a core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 8. The 1st and 2nd optical waveguides can be combined by contacting a core 4 to Salients 10a and 10b by the same method.

[0019] By according to the 1st and 2nd examples like ****, contacting the film-like 3rd optical waveguide which has flexibility to a part of field of the longitudinal direction of the 1st and 2nd optical waveguides, and combining between the 1st and 2nd optical waveguides The flexibility of a film can be used, and the alignment of the angle which the flat surface in which the alignment of the height direction of the 1st and the 2nd optical waveguide, and the 1st and the 2nd optical waveguide are formed makes becomes unnecessary, and can shorten alignment work sharply compared with direct coupling of the conventional end faces. Moreover, by not making end faces couple directly with the optical coupling of optical waveguides, the influence of reflective after-tack light can be prevented.

[0020] Drawing 3 is the cross section showing the 3rd example of this invention. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, 17 is the 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the core of the 3rd optical waveguide and 18 are formed in, and, as for 19, the 3rd core 17 and clad layer 18 of an optical waveguide are formed.

[0021] After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the 1st which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 2nd substrates 3, and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is several microns - about 50 microns, and core width of face is several microns - about 50 microns.

[0022] a core 17 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the 3rd clad layer 18], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle This core 17 may be covered in the thin optical-waveguide clad layer several microns or less if needed. In this way, the 3rd waveguide concerning this example is the 1st and 2nd waveguides and these width of face, and has flexibility.

[0023] Formation of the 3rd optical-waveguide film concerning this example For example, the spin coat cure of an optical-waveguide core layer and the clad layer is carried out on the silicon wafer which is not illustrated. After forming the mask for optical-waveguide core formation by the lift-off method etc., a core 17 is formed by the same method as ****. A taper configuration is produced changing the scanning field of a beam in the depth direction of an optical waveguide one by one in a focused ion beam etc. furthermore, and it is obtained by finally exfoliating the interface of optical-waveguide clad and a silicon substrate. Although the clad layer 8 pastes up the substrates

9, such as an acrylic, further, this substrate 9 can also be omitted if needed.
[0024] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 17 probably, a core 17 is completely contacted to a part of field of the longitudinal direction of the 1st core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 18. By contacting a core 17 and a core 4 by the same method, the 1st and 2nd optical waveguides can be combined.
[0025] Drawing 4 is the cross section showing the 4th example of this invention. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, The 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the core of the 3rd optical waveguide and 18 are formed in, and, as for 17, the 3rd core 17 and clad layer 18 of an optical waveguide are formed, as for 9, and 10 show the salient formed on the 3rd optical-waveguide core.
[0026] After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the substrate 3 which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is several microns - about 50 microns, and core width of face is several microns - about 50 microns.
[0027] a core 17 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the clad layer 18], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle
[0028] Salients 10a and 10b are formed on a core 17, and it consists of the same refractive index as this core 7, width of face, and thickness, and the size of the longitudinal direction is in a core 17, and consists of cores 1 to the length (- unity coupling length) from which the optical power shift to a core 4 from a core 17 serves as the maximum. In addition, Salients 10a and 10b may be covered by thin optical-waveguide clad several microns or less if needed.
[0029] In this way, the 3rd optical waveguide concerning this example is the 1st and 2nd optical waveguides and these width of face, and it has Salients 10a and 10b while it has flexibility.
[0030] Formation of the 3rd optical waveguide concerning this example carries out the spin coat cure of an optical-waveguide core layer and the clad layer on the silicon wafer which is not illustrated, for example. After forming the mask for optical-waveguide core formation by the lift-off method etc., the optical-waveguide layer for heights and the mask for height formation are formed by the same method. Then, after forming simultaneously Salients 10a and 10b and a core 17 by reactive ion etching etc., it is obtained by exfoliating the interface of optical waveguide clad and a silicon substrate.

Although the clad layer 18 pastes up the substrates 9, such as an acrylic, further, this substrate 9 can also be omitted if needed.
[0031] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 17 probably, salient 10a formed on the core 17 is completely contacted to a part of field of the longitudinal direction of a core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 18. By contacting the 2nd optical-waveguide core 4 to salient 10b formed on the core 17 by the same method, the 1st and 2nd optical waveguides can be combined.
[0032] According to the 3rd and 4th examples like ****, since the light by the total reflection in the taper section can also be combined in addition to the same operation as the above-mentioned 1st and 2nd examples, optical coupling efficiency improves that much.
[0033] Drawing 5 is the cross section showing the 5th example of this invention. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, The 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the core of the 3rd optical waveguide and 8 are formed in, and, as for 7, the 3rd core 7 and clad layer 8 of an optical waveguide are formed, as for 9, and 20a and 20b show the salient of the shape of a taper formed on the 3rd optical-waveguide core.
[0034] After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the substrate 4 which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is about several microns, and core width of face is several microns - about 50 microns.
[0035] a core 7 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the clad layer 8], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle This core 7 may be covered by thin optical-waveguide clad several microns or less if needed.
[0036] Salients 20a and 20b consist of the same refractive index as a core 7, width of face, and thickness, and they have the taper in the opposite side which has not carried out phase opposite with the 1st and 2nd optical waveguides while being respectively formed so that phase opposite may moreover be carried out with the 1st and 2nd optical waveguides on a core 7 near the superposition section of the 1st and 2nd optical waveguides and the 3rd optical waveguide.
[0037] In this way, the 3rd optical waveguide concerning this example is the 1st and 2nd optical waveguides and these width of face, and it has Salients 20a and 20b while it has flexibility.

[0038] Formation of the 3rd optical waveguide concerning this example carries out the spin coat cure of an optical-waveguide core layer and the clad layer on the silicon wafer which is not illustrated, for example. After forming the mask for optical-waveguide core formation by the lift-off method etc., the optical-waveguide layer for taper-like heights and the mask for taper-like height formation are formed by the same method. Then, after forming simultaneously Salients 20a and 20b and the core 7 which are made into a taper configuration by reactive ion etching etc., A taper is produced to Salients 20a and 20b, changing scanning fields, such as a beam, in the depth direction of Salients 20a and 20b one by one in a focused ion beam etc., and it is obtained by finally exfoliating the interface of optical-waveguide clad and a silicon substrate. Although a clad layer pastes up the substrates 9, such as an acrylic, further, this substrate 9 can also be omitted if needed.

[0039] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 7 probably, a core 7 is completely contacted to a part of field of the longitudinal direction of a core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 8. By contacting a core 7 and a core 4 by the same method, the 1st and 2nd optical waveguides can be combined.

[0040] Drawing 6 is the cross section showing the 6th example of this invention. The core of the 1st optical waveguide and 2 one among this drawing The clad layer of the 1st optical waveguide, The substrate in which, as for 3, the 1st core 1 and clad layer 2 of an optical waveguide are formed, The substrate [layer / clad / of the 2nd optical waveguide] in which the core of the 2nd optical waveguide and 5 are formed in, and, as for 4, the 2nd core 4 and clad layer 5 of an optical waveguide are formed, as for 6, The 3rd substrate [layer / clad / of the 3rd optical waveguide] in which the 3rd optical-waveguide core and 8 are formed in, and, as for 7, the 3rd core 7 and clad layer 8 of an optical waveguide are formed, as for 9, 10a and 10b pile up with the 1st and 2nd optical waveguides formed on the core 7 of the 3rd optical waveguide, and the salient of business, and 20a and 20b show the salient which has the taper configuration formed on the core 7 of the 3rd optical waveguide.

[0041] After carrying out the spin coat cure of a core 1, a core 4, and the clad layer 2 and the clad layer 5 respectively on the substrate 3 which consists of optical-waveguide material, such as a polyimide system organic material with an equal refractive index, respectively, and consists of an alumina, Si, etc., and 6, it is made into rectangle structure by reactant etching etc. about cores 1 and 4. Respectively, the thickness of cores 1 and 4 and the clad layers 2 and 5 is several microns - about 50 microns, and core width of face is several microns - about 50 microns.

[0042] a core 7 -- cores 1 and 4 -- moreover -- from optical-waveguide material, such as a polyimide system organic material with the clad layers 2 and 5 and a refractive index equal [the clad layer 8], -- changing -- thickness -- several microns - about 50 microns of each, and core width of face -- several microns - about 50 microns and clad width of face -- several -- it is the film of a mm-cm angle

[0043] Salients 10a, 10b, 20a, and 20b are the same refractive index as a core 7, and width of face, and that of the thickness of Salients 10a and 10b are equal to a core 7, and the thickness of Salients 20a and 20b is formed more than the double precision of a core

7. Moreover, Salients 20a and 20b are formed in the position which carries out phase opposite with the 1st and 2nd optical waveguides, and have the taper in the opposite side which has not carried out phase opposite with the 1st and 2nd optical waveguides further. The size of the longitudinal direction of Salients 10a and 10b is length (= unity coupling length) to which it is in a core 7, and the optical power shift to a core 4 from a core 7 serves as the maximum from a core 1. In addition, the salients 10a and 10b formed on the 3rd optical-waveguide core may be covered by thin optical-waveguide clad several microns or less if needed.

[0044] In this way, the 3rd optical waveguide concerning this example is the 1st and 2nd waveguides and these width of face, and it has Salients 10a, 10b, 20a, and 20b while it has flexibility.

[0045] Formation of the 3rd optical-waveguide film concerning this example For example, the spin coat cure of an optical-waveguide core layer and the clad layer is carried out on the silicon wafer which is not illustrated. After forming the mask for optical-waveguide core formation by the lift-off method etc., the optical-waveguide layer for heights and the mask for height formation are formed by the same method. Then, Salients 10a, 10b, 20a, and 20b and a core 7 are simultaneously formed by reactive ion etching etc. After producing a taper, changing the scanning field of a beam in the depth direction of Salients 20a and 20b one by one in a focused ion beam etc. about Salients 20a and 20b, it is obtained by exfoliating the interface of optical-waveguide clad and a silicon substrate. Although the clad layer 8 pastes up the substrates 9, such as an acrylic, further, this substrate 9 can also be omitted if needed.

[0046] In this example, after carrying out alignment with the alignment equipment which is not illustrating the longitudinal direction (x, z shaft orientations) of a core 1 and a core 7 probably, the salients 10a and 10b formed on the core 7 are completely contacted to a part of field of the longitudinal direction of a core 1. After contact is fixed with ultraviolet-rays hardening type adhesives if needed. In this case, the refractive index of adhesives is made equal to the clad layers 2 and 8. The 1st and 2nd optical waveguides can be combined by contacting the 2nd optical-waveguide core 4 to the salients 10a and 10b formed on the 3rd optical-waveguide core by the same method.

[0047] According to the 3rd and 4th examples like ****, it adds to the same operation as the above-mentioned 1st and 2nd examples. By forming the salients 20a and 20b of a taper configuration in the position which faces the 1st optical waveguide on the 3rd optical-waveguide side, and the 2nd optical waveguide The waveguide propagation light which was not able to shift can also carry out optical coupling of the optical power from the 1st optical waveguide or the 2nd optical waveguide to the 3rd optical waveguide.

[0048] In addition, in the 1st like **** - the 6th example, the core 7 does not need to be formed only in a straight line, it turns at it, and circuits, such as branching, may be formed. Moreover, it cannot be overemphasized that the 1st optical waveguide and the 2nd optical waveguide may be formed on the same substrate. Furthermore, optical-waveguide material cannot be overemphasized by that an acrylic material (for example, polymethacrylate) is sufficient. Moreover, the optical coupling structure of this invention cannot be overemphasized by that it is applicable also to a ridge type embedding type waveguide besides a strip type optical waveguide.

[0049]

[Effect of the Invention] By considering as the composition which combines the 1st

optical waveguide and 2nd optical waveguide in the 3rd optical waveguide which consists of a flexible film according to this invention, as concretely explained with the example above It becomes unnecessary, and the alignment of the angle which the flat surface in which the alignment of the height direction of the 2nd optical waveguide, and the 1st and the 2nd optical waveguide are formed makes can shorten alignment work sharply compared with direct coupling of the conventional end faces, and becomes effective in reduction of mounting cost. Moreover, the influence to the optical-waveguide propagation light of the reflective after-tack light in a joint interface can be suppressed by not considering as direct coupling of end faces.

[Translation done.]